



# DIVERSITY OF FISH LARVAE ON THE SHORE OF TERENGGANU AND PAHANG WATERS





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## FOREWORD

The coastal waters of the east coast of Peninsular Malaysia are very important to Malaysia in terms of its fisheries resources. Islands across these waters support the diversity of fish species. Many studies have been conducted to determine the adult fish diversity and its biomass, but there are very few efforts to study their early life history. Research on fish larvae is still scanty in Malaysia compared to other countries such as Japan, Australia, and the United States. Prolonged and continuous studies on fish larvae will enable us to understand their morphology, spawning season, spawning area, and nursery grounds which are important for fisheries management. Information on fish larvae is also one of the methods for stock assessment.

The identification of fish larvae up to the genus or species level is the most important step. However, the guide for species identification is still limited, especially on tropical fish. This book will offer a guide on fish larvae identification based on selected families of fish larvae collected on coastal waters of the east coast of Peninsular Malaysia, particularly in Terengganu and Pahang waters. The photos of fish larvae and stained specimen are enclosed in this book. It will enable the readers to make a comparison with their specimens which ensures the morphological aspects are more discernible for identification purposes.

Overall, it is hoped that this book will assist researchers in the identification of fish larvae. In future publications, other fish larvae families will be included.

## ACKNOWLEDGMENTS

This book is one of the outcomes from the studies on fish larvae by the authors, especially in the coastal waters of Terengganu and Pahang. This is a guidebook on fish larvae on common fish families and does not contain as many families as the guides by established authors.

The authors would like to express their sincere gratitude to the Director-General of The Department of Fisheries Malaysia, YBr. Tuan Ahmad Tarmidzi bin Ramly for his support in the preparation of this book. Special thanks to ex-Chief of SEAFDEC/MFRDMD, YBr. Dr. Ahmad bin Ali for his encouragement and advice.

Last but not least, the authors are indebted to the staff of SEAFDEC/MFRDMD and industrial trainees from Universiti Kebangsaan Malaysia (UKM), Ms. Noralia Suhaila binti Mohd Yusof and Ms. Nur Aina Syahirah binti Ab. Latif who were involved in the collection of the specimens and the laboratory works.

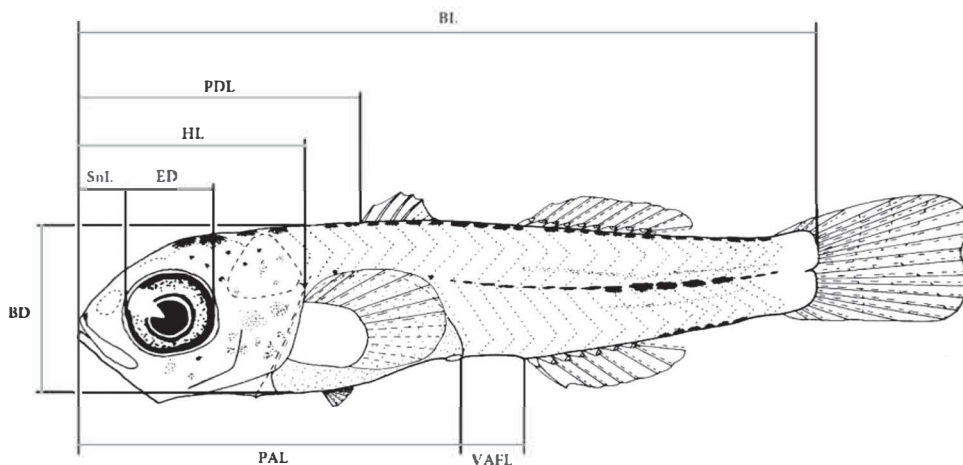


# GENERAL BODY MORPHOLOGY (Adapted from Leis and Carson-Ewart, 2000)

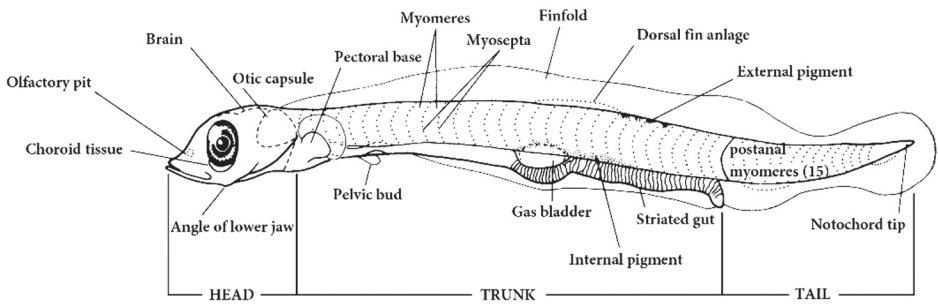
## Abbreviation

These abbreviations are used throughout the text

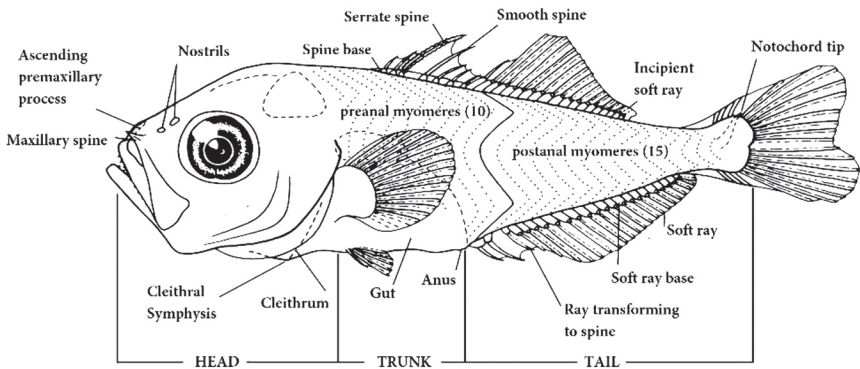
|     |                     |                  |                         |
|-----|---------------------|------------------|-------------------------|
| A   | Anal fin            | NL               | Notochord length        |
| BD  | Body depth          | P <sub>1</sub>   | Pectoral fin            |
| BL  | Body length         | P <sub>1</sub> L | Pectoral-fin length     |
| BW  | Body width          | P <sub>2</sub>   | Pelvic fin              |
| C   | Caudal fin          | P <sub>2</sub> L | Pelvic-fin length       |
| D   | Dorsal fin          | PAL              | Preanal length          |
| DSL | Dorsal spine length | PDL              | Predorsal-fin length    |
| ED  | Eye diameter        | SL               | Standard length         |
| HL  | Head length         | SnL              | Snout length            |
| HW  | Head width          | TL               | Total length            |
| MW  | Mouth width         | VAFL             | Vent to anal-fin length |



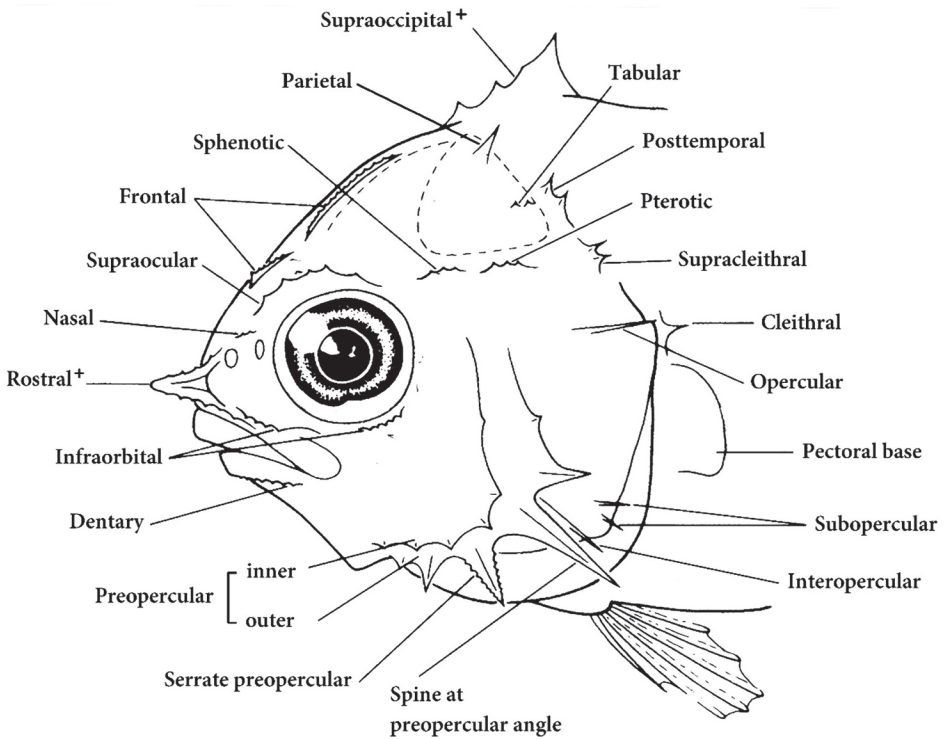
**Figure 1:** Postflexion mullid larva showing the routine measurements. Abbreviations are defined in the text.



**Figure 2:** Hypothetical preflexion larva.



**Figure 3:** Hypothetical postflexion larva.



**Figure 4:** Hypothetical fish larvae showing major morphological characters. Head spines marked with ‘+’ are unpaired medial spines.

## GLOSSARY

|                             |  |
|-----------------------------|--|
| <b><i>Body depth</i></b>    | The vertical distance between body margins (exclusive of fins) through the anterior margin of the pectoral fin base.   |
| <b><i>Body length</i></b>   | The size of the larva; corresponds to notochord length in pre-flexion and flexion larva and to standard length after flexion.  |
| <b><i>Body width</i></b>    | The transverse distance between body margins at the pectoral fin base.   |
| <b><i>Cleithrum</i></b>     | A prominent bone of the pectoral girdle, clearly visible in many fish larvae.  |
| <b><i>Eye diameter</i></b>  | The horizontal distance across the midline of the pigmented region of the eye.   |
| <b><i>Flexion</i></b>       | Bending upward of the notochord tip as part of the process of caudal fin formation.  |
| <b><i>Flexion larva</i></b> | The development stage begins with flexion of the notochord and ends with the hypural bones assuming a vertical position.   |
| <b><i>Gas bladder</i></b>   | A membranous, gas-filled organ located between the kidneys and alimentary canal in teleost fishes; air bladder or swim bladder.  |
| <b><i>Head length</i></b>   | The horizontal distance from the tip of snout to posterior-most part of the opercular membrane, prior to the development of operculum, measured to the posterior margin of cleithrum.                                      |
| <b><i>Juvenile</i></b>      | Development stage from the attainment of full external meristic complements and loss of temporary specializations for pelagic life to sexual maturity.   |
| <b><i>Larva</i></b>         | Development stage between hatching (or birth) and attainment of full external meristic complements (fins and scales) and loss of temporary specializations for pelagic life; yolk-sac through postflexion stage inclusive. |
| <b><i>Melanophores</i></b>  | Melanin-bearing cells (brown to black); frequently capable of expansions and contractions which change their size and shape.   |

|  |  |
|--|--|
| <b><i>Myomeres</i></b>                                   | Serial muscle bundles of the body.   |
| <b><i>Myosepta</i></b>                                   | Connective tissue partitions that separate adjacent myomeres.  |
| <b><i>Notochord</i></b>                                  | The longitudinal supporting axis of the body, which is eventually replaced as a support by the vertebral column in teleostean fishes.  |
| <b><i>Notochord length</i></b>                           | Straight line distance from the tip of snout to the posterior tip of notochord; used prior to and during flexion.  |
| <b><i>Postflexion larva</i></b>                          | Developmental stage from the formation of the caudal fin (hypural elements vertical) to the attainment of full external meristic complements (fin rays and scales) and loss temporary specialization for pelagic life.   |
| <b><i>Preflexion larva</i></b>                           | The developmental stage begins at hatching and ends at the start of upward flexion of the notochord.   |
| <b><i>Snout length</i></b>                               | The horizontal distance from the tip of the snout to the anterior margin of the pigmented region of the eye.   |
| <b><i>Soft rays</i></b>                                  | Bilaterally paired, usually segmented fin supports, often referred to as rays.   |
| <b><i>Standard length</i></b>                            | Distance from the tip of the snout along the midline to a vertical line through the posterior edge of the hypural plate.   |
| <b><i>Temporary specializations for pelagic life</i></b> | Morphological (not pigment) characters such as trailing guts, preopercular spines, elongate fin spines, or gas bladders, which are not retained in adults but are present during the pelagic phase. Often these are lost after settlement, but if present in settled individuals, they are clearly reduced and are disappearing. |
| <b><i>Total length</i></b>                               | Distance from the tip of snout along the midline to the posterior edge of the caudal fin fold; body length is traditionally expressed as the total length in Japanese literature.  |
| <b><i>Yolk sac</i></b>                                   | A bag-like, ventral extension of the primitive gut containing the yolk.  |
| <b><i>Yolk-sac larva</i></b>                             | The developmental stage begins with hatching and ending with the exhaustion of yolk reserves and is characterized by the presence of a yolk sac.   |

# LARVAL DESCRIPTION

## Ambassidae – Glass Perchlets

### General Morphology

Larvae of Ambassidae are moderate in-depth and compressed. The eye is round with moderate to large in size. The small mouth is oblique and does not reach the anterior edge of the eye.

### Head Spination

Head spination is weakly developed in larvae but highly developed in adults. The development of the spines in adults depends on the species. Very small preopercular spines are present at the flexion stage. Notochord flexion occurs at a relatively small size.

### Pigmentation

All ambassids larvae are lightly pigmented with a series of small, closely spaced melanophores on the ventral midline of the tail that move onto fin-ray bases and coalesce. There are also a few melanophores on the caudal-fin base. Two to three prominent melanophores ventrally on the gut. On the angle of the lower jaw, on the gut, and on the gas bladder.

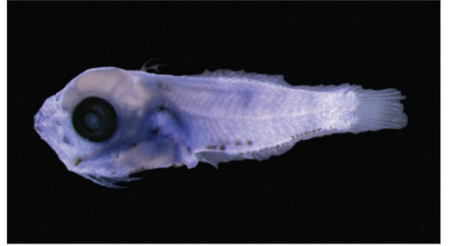
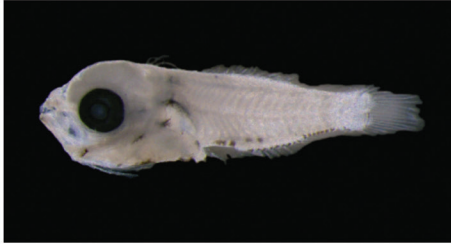
### Diagnostic Character

The larvae have 24 myomeres. The gut is small, tightly coiled, and triangular in shape. Following a larva growth, the conspicuous gas bladder increases in size. Initially, the head is compressed and round. However, in postflexion larvae, the head becomes slightly elongated. The larva of Ambassidae has a short and steep snout with a slightly concave to irregular rounded in profile. It then becomes less steep in conjunction with the lengthening of the head. Incipient rays appear during flexion, and the soft rays become ossified in early postflexion larvae.

### Similar group

The ambassids larvae are often confused with larvae of apogonids, gerreids, pomacentrids, sparids, terapontids, and nemipterids due to their limited head spination and tightly coiled guts. Preflexion of nemipterids and ambassids is extremely similar. However, nemipterids lack melanophores on the lower jaw, an inflated and conspicuous gas bladder, preopercular spination in postflexion, and the head is less compressed.

A



**Flexion:** SL:3.23, HL:1.24, ED:0.48, BD:0.97

**Figure 5:** A larva of ambassid collected from Terengganu waters. A: 3.23 mm **flexion** stage.

## **Apogonidae - Cardinalfishes**

### **General Morphology**

Apogonidae larvae general body shape varies from slightly laterally compressed and elongate to strongly laterally compressed and deep bodied. Depending on the species, the head shape varies from large, deep, laterally compressed head with a short, round to truncate snout to moderate size of the head with an elongate snout.

### **Head Spination**

Head spination is present, and it varies among species. It is either completely lacking or present in the form of spines on the preopercle, interopercle, subopercle, opercle, supercleithrum, post-temporal, pterotic, or supraocular ridge and a small supraoccipital crest with a single spine. Generally, head spination appears during the preflexion stage and disappears or is reduced greatly and immediately due to settlement.

### **Pigmentation**

The pigmentation of apogonids larvae varies from being light and restricted to being heavy and spread over most of the body. Pigmentation persistently occurs on the dorsal surface of the gas bladder.

### **Diagnostic Character**

The larvae of apogonids have 23 to 24 myomeres, a coiled gut during the early preflexion stage, a large and conspicuous gas bladder. It also has a large mouth that reaches the mid-eye. The eye is rounded with moderate to large in size. Fin development is extremely variable.

### **Similar group**

The larvae of apogonids are often confused with larvae from family acropomatids, ambassids, berycids, carangids, gerreids, kyphosids, lactariids, lethrinids, leptobramids, opistognathids, pempheridids, plesiopids, and serranine serranids.



A



**Preflexion:** NL:2.88, HL:0.91, ED:0.38, BD:0.90,  
Artificial reef of oil rigs.

B



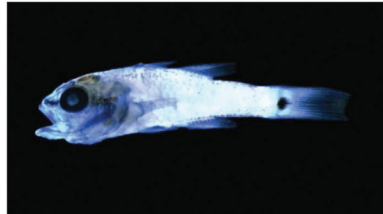
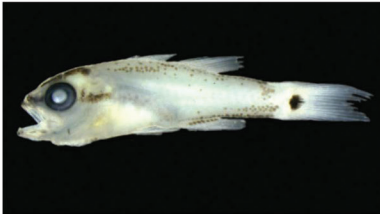
**Flexion:** NL:4.99, HL:1.70, ED:0.56, BD:1.61,  
Artificial reef of oil rigs.

C



**Flexion:** NL:5.01, HL:1.91, ED:0.63, BD:1.76,  
Artificial reef of oil rigs.

D



**Postflexion:** SL:10.98, HL:4.14, ED:1.27, BD:3.06,  
Artificial reef of oil rigs.

**Figure 6:** The larvae of apogonids collected from Pulau Kapas waters. **A:** 2.88 mm **preflexion**, **B:** 4.99 mm **flexion**, **C:** 5.01 mm **flexion** and **D:** 10.98 mm **postflexion** stage.

## **Bothidae - Lefteye Flounders**

### **General Morphology**

The larvae of Bothidae are extremely laterally compressed and vary in body shape both ontogenetically and among species. The larvae are initially elongated and bilaterally symmetrical but change shape with growth. They may become fairly slender, ovate, or deep and round. The trunk and tail of the larvae are often much deeper than the head. Initially, the head is moderate to small and squarish, but as it grows, it becomes more rounded and relatively smaller in size.

### **Head Spination**

Depending on the genus, Bothidae larvae have a minute to small spines that can be found along the edges of the urohyal posterior pelvic process and cleithrum.

### **Pigmentation**

The pigmentation of Bothidae larvae varies among the taxa. It is generally sparse to absent and develops only on the sinistral side, but some larvae have similar pigmentation on both sides. In some taxa, pigmentation also occurs along both the dorsal and ventral margins of the head and fins. It also can be found as spots or blotches laterally on the body.

### **Diagnostic Character**

The larvae of Bothidae have 32 to 60 myomeres. The gut tube is small in diameter. However, it develops a single coil that elongates vertically with growth shortly after hatching. The gas bladder is small to moderate in size and is usually inflated during the night. Initially, it is located dorsal to the anterior portion of the gut coil or slightly anterior to this.

### **Similar group**

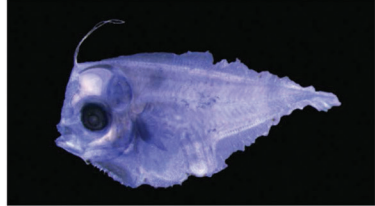
They are likely to be confused only with other flatfish larvae like Cynoglossidae, Pleuronectidae, Psettodidae, Paralichthyidae, Citharidae, and Soleidae.

A



**Preflexion:** NL: 2.98, HL: 0.80, ED: 0.31, BD: 0.86

B



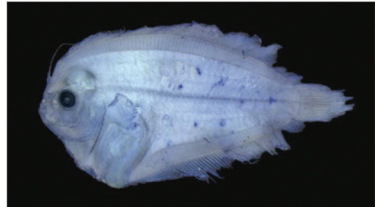
**Flexion:** NL: 4.12, HL: 1.16, ED: 0.39, BD: 1.82

C



**Flexion:** NL: 6.46, HL: 1.66, ED: 0.40, BD: 2.68

D



**Postflexion:** SL: 12.39, HL: 3.15, ED: 0.74, BD: 6.85

**Figure 7:** The larvae of bothids collected from Pulau Kapas waters. A: 2.98 mm **preflexion**, B: 4.12 mm **flexion**, C: 6.46 mm **flexion** and D: 12.39 mm **postflexion** stage.

## **Bregmacerotidae - Codlets**

### **General Morphology**

Its body is moderately compressed, and the gut is tightly coiled. The head changes from rounded to nearly straight while the mouth is oblique. The bregmacerotids larvae have round and moderate eyes. The pelvic fins rays become thick and very elongate, reaching well past the anus. The dorsal and anal fins are formed from anterior and posterior, leading toward the middle of the fin, which will be the shortest in the adult phase. The pectoral fins are paddle-like and located well above the lateral midline.

### **Head Spination**

No head spination.

### **Pigmentation**

The pigmentation of bregmacerotids larvae varies from sparse to heavy, depending on the species and stages of the larvae. Most species have pigments on their gas bladder and at the angle of the lower jaw. The bregmacerotid larvae have many internal pigments, especially on the gas bladder, tail portion, and at the peduncle caudal. As the larvae grow, pigmentation also increases.

### **Diagnostic Character**

Paddle-like pectoral fin and early forming pelvic fins.

### **Similar group**

They are likely to be confused with stylephorids. Stylephorids can be distinguished from bregmacerotids as they have fewer anal fins and much smaller mouths.

A



**Preflexion:** NL: 3.42, HL: 0.96, ED: 0.37, BD: 1.07

B



**Flexion:** SL: 3.58, HL: 1.28, ED: 0.40, BD: 1.31

C



**Postflexion:** TL: 6.81, HL: 1.84, ED: 0.48, BD: 1.76,  
Artificial reef of a fishing vessel.

**Figure 8:** The larvae of bregmacerotids collected from Pulau Kapas waters. **A:** 3.42 mm **preflexion**, **B:** 3.58 mm **flexion**, and **C:** 6.81 mm **postflexion** stage.

# **Callionymidae - Dragonets**

## **General Morphology**

The larvae are robust and of moderate depth. In postflexion, the body and head flatten dorsoventrally. In flexion, the posterior end of the notochord is greatly produced beyond the last myomere. At the end of flexion, the notochord tip extends well past the hypural plate and maybe as long as the caudal fin rays and this tip extension begin to disappear.

## **Head Spination**

The only head spination is a posteriorly-directed preopercular spine that begins to form following the full development of the soft rays of the medial and pelvic fins.

## **Pigmentation**

The Callionymidae larvae are generally heavily pigmented, especially on the ventral as compared to dorsal surfaces. All species are moderate to heavily pigmented on the ventrum, and most are moderately pigmented on the head, lower jaw, dorsum of the gut, and on the lateral and dorsal surface of the tail. Most larger larvae have moderately pigmented pectoral-fin bases and melanophores on the pelvic, pectoral, and first dorsal-fin elements.

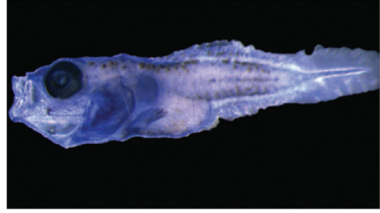
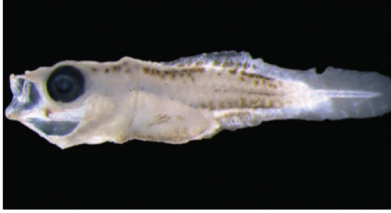
## **Diagnostic Character**

They are initially round in cross-section and have 20-22 myomeres. The coiled, rotund gut extends at least the midbody. The gas bladder lies anteriorly above the gut but is relatively inconspicuous. The moderate to large head is initially rounded but broadens and becomes relatively longer and dorsoventrally flattened after flexion. The snout is short but elongates slightly with increasing body size.

## **Similar group**

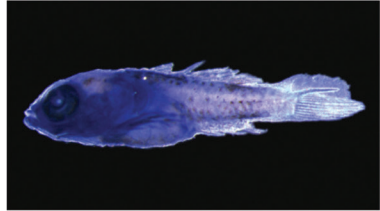
The Callionymidae is most likely similar to Draconettidae, Mugilidae, Percophidae.

A



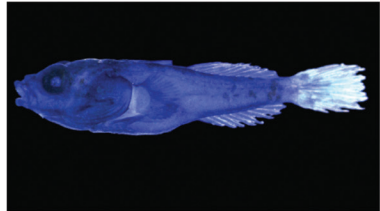
**Preflexion:** NL:3.27, HL:1.09, ED:0.35, BD:0.73

B



**Flexion:** NL:3.71, HL:1.31, ED:0.48, BD:0.90

C



**Postflexion:** SL:8.53, HL:3.38, ED:0.81, BD:2.17

**Figure 9:** The larvae of callionymids collected from Pulau Kapas waters. **A:** 3.27 mm **preflexion**, **B:** 3.71 mm **flexion** and **C:** 8.53 mm **postflexion** stage.

## **Carangidae – Jacks, Pompanos**

### **General morphology**

The carangid larvae are strongly compressed and initially range from the most slender, extreme, or moderate to deep-bodied. Many species become deeper with growth. The carangid head shape varies widely among species, but in postflexion larvae, they are usually roundly triangular.

### **Head spination**

The preopercular and supraoccipital spination are both distinctive. A supraoccipital crest is present from the early preflexion stage with variations in sizes and shapes. A low to very low supraocular ridge forms in the late preflexion stage.

### **Pigmentation**

Series of melanophores found on the dorsal and ventral midlines of the trunk or tail and mid-laterally on the trunk or tail. Pigment usually occurs on the snout and brain, along the lower jaw, over the gas bladder, and on the notochord tip. The caudal peduncle is usually the last area to become pigmented. In the postflexion stage, pigment spreads abruptly.

### **Diagnostic Character**

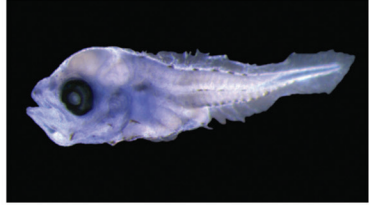
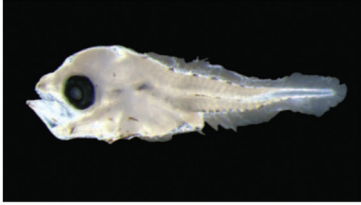
There are 24-25 myomeres. The head spination are preopercular and supraoccipital spination; absence of subopercular, interopercular, or opercular spination. The gut is initially straight but begins to coils in roundly triangular. The conspicuous gas bladder is located over the gut coil. The head is moderate to large in preflexion larvae but is large in postflexion larvae. The short to moderate snout is initially concave but becomes convex by the postflexion stage and varies from triangular to blunt.

### **Similar group**

The Carangidae is most likely to be confused with Lactariidae, Nomeidae, Chaetodontidae, Pomacanthidae, Menidae, Citharidae, Pempherididae, Apogonidae, and the serranid subfamily Anthiinae.

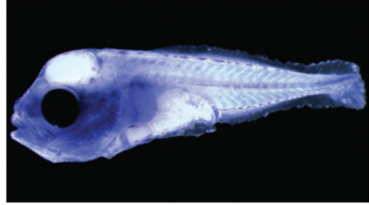


A



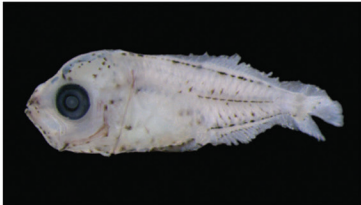
**Preflexion:** NL:2.94, HL:0.96, ED:0.35, BD:0.82

B



**Flexion:** NL:4.19, HL:1.33, ED:0.49, BD:1.22 (Type 1)

C



**Flexion:** NL:4.51, HL:1.60, ED:0.53, BD:1.51

D



**Postflexion:** TL:9.50, HL:3.52, ED:1.08, BD:3.63

**Figure 10:** The larvae of carangids collected from Kuala Pahang waters. **A:** 2.94 mm **preflexion**, **B:** 4.19 mm **flexion**, **C:** 4.51 mm **flexion** and **D:** 9.50 mm **postflexion** stage.

## **Centriscidae – Razorfishes**

### **General Morphology**

The larvae are laterally compressed with an elongate notochord tip. There is also a carapace with a posteriorly-directed spine and a downward bend to the tail in postflexion larvae.

### **Head Spination**

No spines on the opercular series, but two small spines develop on the lower jaw shortly after flexion. Large pyramidal spines form dorsolaterally on the trunk and tail.

### **Pigmentation**

The larvae are moderate to heavily pigmented with small distinct melanophores on the head and trunk and the first few postanal myomeres. Pigment also occurs on the dorsal- and anal-fin bases and on the fin membranes.

### **Diagnostic Character**

There are 20-21 myomeres. The body of the centriscid is elongated to moderate in depth before flexion. The long gut and large gas bladder are present. The head is moderate to large and laterally compressed. The snout is initially short and rounded but begins to become long and tubular. The mouth is small and opens dorsally. The eye is round to squarish in early preflexion larvae but becomes rounded by the mid preflexion stage. Initially, the eyes are large, but the size is relative to the head, which quickly becomes small due to the extreme length of the snout.

### **Similar Group**

During the early larva stage, centriscids are most likely to be confused with syngnathid or solenostomid.

**A**



**Preflexion:** NL:2.86, HL:0.84, ED:0.26, BD:0.48

**B**



**Preflexion:** NL:4.46, HL:1.48, ED:0.41, BD:0.82

**C**



**Flexion:** NL:5.74, HL:2.24, ED:0.49, BD:0.94,  
Artificial reef of oil rigs.

**D**



**Flexion:** NL:7.04, HL:2.79, ED:0.47, BD:1.07,  
Artificial reef of oil rigs.

**Figure 11:** The larvae of centriscids collected from Pulau Kapas waters. **A:** 2.86 mm **preflexion**, **B:** 4.46 mm **preflexion**, **C:** 5.74 mm **flexion** and **D:** 7.04 mm **flexion** stage.

## **Cepolidae - Bandfishes**

### **General Morphology**

The larvae of cepolids have a moderate depth of the trunk. The tail is elongated, compressed, and tapering. The head of the larva is broad and moderate to large in size. The head is approximately round with a prominent jaw angle.

### **Head Spination**

The head spination is present and very heavy. It consists of a large supraoccipital spine with serrate edges. The supraocular ridge with a serration; the dentary ridge serrate. Preopercular spines include a very long, serrate spine at the angle; and a rugose frontal region. Supracleithral and post-temporal with spines.

### **Pigmentation**

Generally, pigmentation on cepolids larvae is light to moderate. Melanophores appear on the dorsal surface of the head, gut, gas bladder, on the lateral surface of the operculum, and along the ventral midline of the tail.

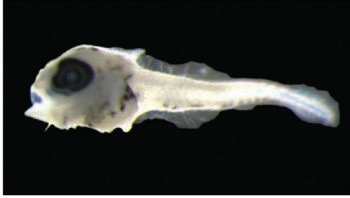
### **Diagnostic Character**

The cepolids larvae have 23 to 79 myomeres. The triangular gut is strongly coiled. The conspicuous gas bladder is located above the apex of the gut. The snout is short, rounded, and irregular in the preflexion stage and gradually increases in size and becomes oblique with growth. The eye is round with moderate to large in size.

### **Similar group**

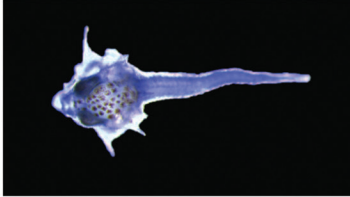
They are often confused with larvae of similar head spination from caproids, priacanthids, lethrinids, lobotids, holocentrids, acropomatids, leiognathids, ephippidids, and drepaneids. The myomeres are the easiest feature used to differentiate those families as cepolids have 48 to 79, and the owstoniines have 28 to 31 myomeres while the other families have 23 to 26 myomeres.

A



**Preflexion:** NL:2.34, HL:0.66, ED:0.28, BD:0.57

A1



Dorsal view

B



**Flexion:** NL:5.34, HL:1.60, ED:0.65, BD:1.60

**Figure 12:** The larvae of cephalopods collected from Pulau Kapas waters. **A:** 2.34 mm **preflexion** and **B:** 5.34 mm **flexion** stage.

# **Cynoglossidae -Tonguefishes**

## **General Morphology**

The cynoglossids larvae are initially elongated to moderate in-depth, compressed, and laterally symmetrical.

## **Head Spination**

Spination is present on the rostral hook of the head.

## **Pigmentation**

In cynoglossids, clusters and longitudinal series of melanophores are initially found along the dorsal and ventral body margins. Pigment also appears on the dorsal surface of the gas bladder, elongate dorsal rays, pectoral fin, and, in postflexion larvae, mid-laterally on the tail.

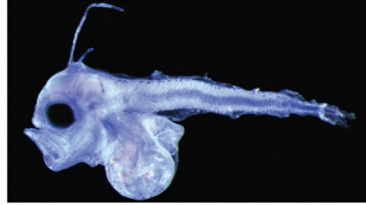
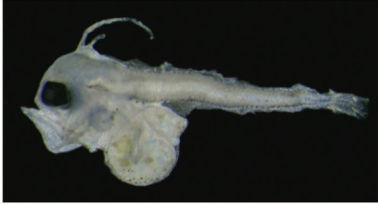
## **Diagnostic Character**

The cynoglossids larvae become extremely compressed and deeper after notochord flexion is complete. The head and trunk are initially much deeper than the tapering tail. The tail gradually becomes deeper, but it remains less deep than the rest of the body. There are 43-59 myomeres. The gut is thick and coiled into a single, large loop and protrudes markedly from the ventral body margin. The gas bladder is located over the posterior portion of the gut. It is inflated at night but otherwise is small and apparently disappears during transformation. The small to only just moderate head is initially deep and round and has a short, rounded snout. The moderate mouth reaches the posterior margin of the pupil. The round eyes are initially moderate to large but are small to moderate in postflexion larvae.

## **Similar groups**

The cynoglossids larvae are likely to be confused with carapids, exteriium larvae of some ophidioids, and other flatfishes.

A



**Preflexion:** NL:2.35, HL:0.52, ED:0.20, BD:0.71

B



**Preflexion:** NL:4.10, HL:0.88, ED:0.27, BD:1.03

C



**Preflexion:** TL:5.46, HL:0.84, ED:0.25, BD:0.91

D



**Flexion:** NL:6.62, HL:1.52, ED:0.35, BD:2.08

**Figure 13:** The larvae of cynoglossids collected from Kuala Pahang waters. **A:** 2.35 mm **preflexion**, **B:** 4.10 mm **preflexion**, **C:** 5.46 mm **preflexion**, **D:** 6.62 mm **flexion** stage.

## **Drepaneidae - Sicklefishes**

### **General Morphology**

The larvae of drepaneids are initially deep-bodied with a relatively rotund head and trunk and a relatively compressed tail. They become increasingly deep-bodied and laterally compressed with growth.

### **Head Spination**

The head spination is well-developed and complex. The spination is comprised of a supraoccipital ridge, a narrow spine associated with the dorsal margin of the interopercle, small to large spines associated with the inner and outer borders of the preopercle, and a small supraocular ridge.

### **Pigmentation**

The larvae are initially lightly pigmented. Preflexion larvae variously possess scattered melanophores associated with the snout, abdomen, pelvic- and pectoral-fin rays, gas bladder, and the gut. The rest of the body is unpigmented.

### **Diagnostic Character**

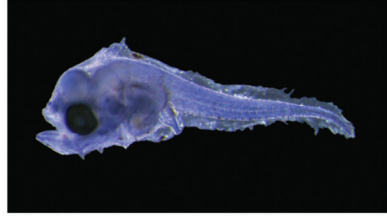
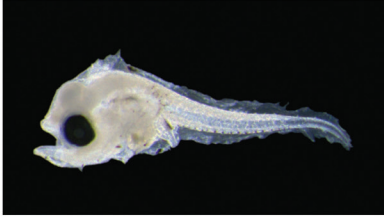
There are 24 myomeres. The large, triangular gut is tightly coiled. The inconspicuous gas bladder is centered over the gut and elongates posteriorly with growth. The head is large and initially round but, after notochord flexion, it develops a steep profile and becomes increasingly deep. The short snout is slightly concave in preflexion larvae and becomes rounded during the flexion and early postflexion stages. The mouth is initially large, slightly oblique, and the maxilla reaches the posterior margin of the pupil. The eye is large and round in the smallest specimen, but in large larvae, relative eye size ranges from small to moderate. All dorsal- and anal- fin elements are present, but the first soft ray of each fin transforms into a spine.

### **Similar groups**

The drepaneids larvae are likely to be confused with the closely-related and very similar ehippid larvae.

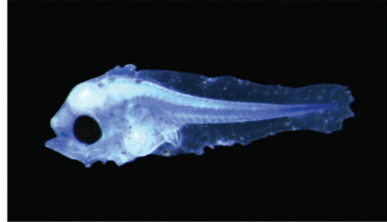
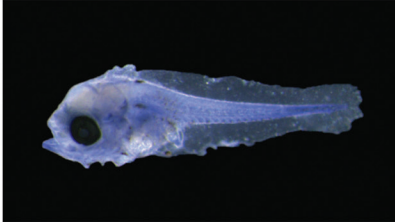


A



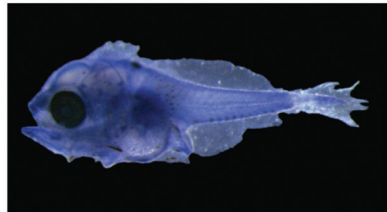
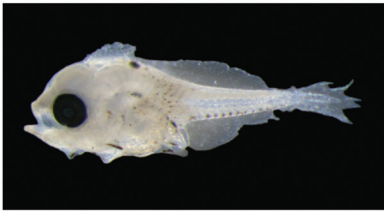
**Preflexion:** NL:2.27, HL:0.61, ED:0.24, BD:0.61

B



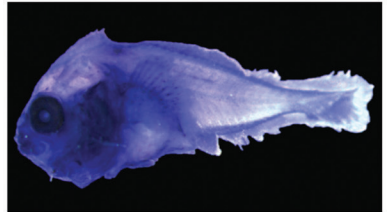
**Preflexion:** NL:2.59, HL:0.73, ED:0.27, BD:0.69

C



**Preflexion:** NL:2.87, HL:0.89, ED:0.35, BD:0.91

D



**Flexion:** NL:3.99, HL:1.20, ED:0.45, BD:1.50

**Figure 14:** The larvae of drepaneids from Kuala Pahang waters. **A:** 2.27 mm **preflexion**, **B:** 2.59 mm **preflexion**, **C:** 2.87 mm **preflexion** and **D:** 3.99 mm **flexion** stage.

## **Engraulidae – Anchovies**

### **General Morphology**

The engraulids larvae are very elongate and initially have a cylindrical body that becomes moderately compressed by the end of the flexion. There are 39-46 myomeres. The gut is long and straight. The head is initially slightly depressed, and by the end of the preflexion stage, it is moderately to strongly depressed, depending on the species. The mouth is initially small, and the maxilla reaches the anterior half of the eye. The gas bladder is apparent from the flexion stage and is inflated only at night.

### **Head Spination**

No head spination.

### **Pigmentation**

The engraulids larvae are lightly pigmented but have a remarkably consistent pattern of pigmentation on the gut. Initially, most of the pigment is located ventrally on the trunk and tail: a single row of melanophores on the midline of the isthmus; a row of melanophores dorsolaterally on the foregut, but which extends to the anus in some species; a row of melanophores on the ventral midline of the hindgut; a row of melanophores on the ventral midline of the tail; and a few melanophores at the notochord tip. Most species also develop pigment dorsolaterally on the gas bladder. The pigment on the ventral midline of the hindgut disappears during the flexion or early postflexion stage. Other species-dependent pigments may appear on the operculum, on the brain, along the cleithrum, internally above the hindgut, on the dorsal- and anal-fin bases, on the dorsal midline of the tail, and on the caudal fin.

### **Diagnostic Character**

The eyes are large but otherwise are small to moderate, depending on species and stage of development. Posteriorly-located dorsal and anal fin appears in preflexion larvae. The dorsal fin differentiates slightly earlier than the anal fin. Incipient rays are present by the end of the preflexion stage. The dorsal fin has fewer fin rays than the anal fin. The gut may overlap the anal-fin origin by, at most, one ray base.

### **Similar group**

Many engraulid's characteristics are shared with other larval such as clupeiforms and gonorynchiforms.

A



**Preflexion:** NL:4.11, HL:0.83, ED:0.27, BD:0.47

B



**Preflexion:** NL:5.85, HL:1.09, ED:0.35, BD:0.65

C



**Flexion:** NL:7.98, HL:1.65, ED:0.41, BD:0.82,  
Artificial reef of oil rigs.

**Figure 15:** The larvae of engraulids from Pulau Kapas waters. A: 4.11 mm **preflexion**, B: 5.85 mm **preflexion** and C: 7.98 mm **flexion** stage.

## **Gerreidae - Mojarras, Silver Biddies**

### **General Morphology**

The larvae are of moderate depth, ovoid in cross-section.

### **Head Spination**

Small preopercular spines are present and weak.

### **Pigmentation**

The gerreids larvae have distinctive pigmentation. For preflexion, the larvae have small melanophores along the ventral midline extending from just posterior to the vent to the tip of the notochord. Following flexion, pigment is found along the anal-fin base, and the melanophores originally at the tip of the notochord are found along the base of the caudal rays. The pigment is also found along the dorsal and anterior surfaces of the gut and, following flexion, on the ventrum of the gut. In larger postflexion stage larvae, pigment develops on the head, notochord, and dorsal midline of the caudal peduncle.

### **Diagnostic Character**

There are 23-25 myomeres. They become more laterally compressed following flexion. In the preflexion stage, the gut is fully coiled and is then triangular and compact. A small, inconspicuous gas bladder is present above the anterior portion of the gut. In the preflexion stage, the larva has a moderate to large head, is broad and round but becomes more laterally compressed with increasing body size. The snout is short and round initially but becomes larger and triangular following flexion. The mouth initially reaches about the anterior edge of the eye, but in postflexion larvae, it becomes larger, reaching as much as the mid-eye. The round eye is large in preflexion larvae and moderate to large thereafter. The dorsal and anal fin anlagen develop during flexion.

### **Similar group**

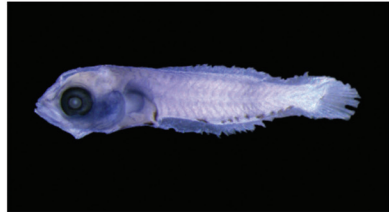
The gerreids are most likely confused with ambassids, haemulids, microcanthids, mullids, pomacentrids, sciaenids, sparids, and terapontids.

A



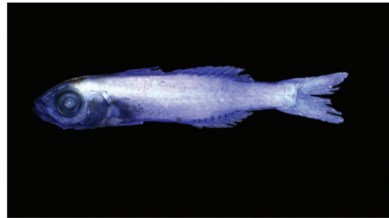
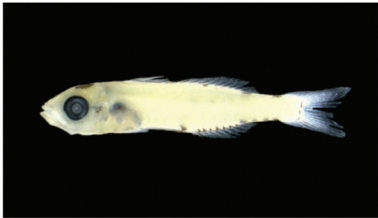
**Flexion:** NL:3.60, HL:1.09, ED:0.45, BD:0.80

B



**Flexion:** NL:4.21, HL:1.27, ED:0.46, BD:0.91

C



**Postflexion:** SL:9.55, HL:2.67, ED:0.97, BD:1.86

**Figure 16:** The larvae of gerreids from Pulau Kapas waters. **A:** 3.60 mm **flexion**, **B:** 4.21 mm **flexion** and **C:** 9.55 mm **postflexion** stage.

## **Gobiidae – Gobies**

### **General Morphology**

The Gobiids have elongated to moderate in-depth, usually with a small change in depth from head to tail with a long caudal peduncle. The body is round to the ovoid. The rounded eye is large and decreases following the flexion.

### **Head Spination**

No head spination.

### **Pigmentation**

Generally, pigmentation occurs lightly on the dorsal surface of the gas bladder and over the hindgut just anterior to the anus. It is often found on the ventrum of the gut and at the isthmus and pelvic-fin base.

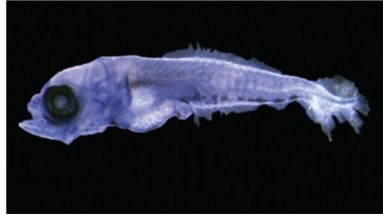
### **Diagnostic Character**

The larva of gobiids has 24 to 27 myomeres. The gut is straight or gently curved below the gas bladder and extends to approximately mid-body. A large gas bladder is located midway along the gut. The head is small to moderate in size before flexion and moderate in postflexion. The post-eye portion of the head increases in relative size following flexion. The snout is small and pointed to rounded as the flexion increase. The oblique mouth reaches to beyond the anterior edge of the eye. The soft rays of the anal, dorsal and pectoral fins begin to form at the start of flexion. However, it is only fully developed at the postflexion stage.

### **Similar group**

The Gobiids are most likely to be confused with apogonids, scarids, cirrhitids, sillaginids, sphyraenids, or myctophids.

A



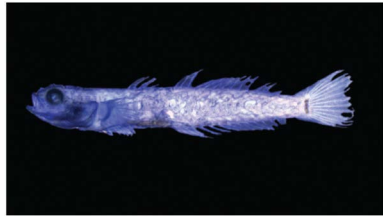
**Flexion:** NL:3.00, HL:0.79, ED:0.35, BD:0.63

B



**Flexion:** NL:4.00, HL:1.07, ED:0.35, BD:0.80

C



**Postflexion:** SL:13.00, HL:3.05, ED:0.82, BD:1.96

**Figure 17:** The larvae of gobiids from Pulau Kapas waters. **A:** 3.00 mm **flexion**, **B:** 4.00 mm **flexion**, **C:** 13.00 mm **postflexion** stage.

## **Labridae – Wrasses**

### **General Morphology**

Generally, labrids larvae are elongate to moderate in-depth and laterally compressed. The caudal peduncle is usually deep. The head is laterally compressed and varies in shape, which is from triangular and moderate in size to large and deep.

### **Head Spination**

No head spination.

### **Pigmentation**

In most cases of postflexion pigmentation, labrids larvae are unpigmented. However, it may occur limited to a few melanophores that can be found above the vent, on the posterior dorsal and ventral midlines of the tail, along the myosepta of the tail, on the dorsum of the gut, on the brain, on the lower jaw or on the dorsal fin and anal fin elements.

### **Diagnostic Character**

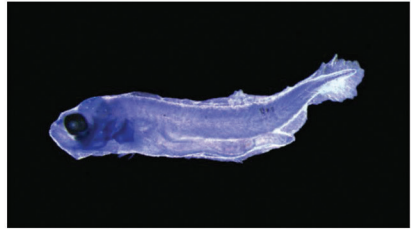
The larvae of labrids have 23 to 28 myomeres. The gut is initially straight and coil depending on the species and ranges from the mid preflexion to the late postflexion stage. The gas bladder is small in size and often inconspicuous. It is located above the anterior to the middle portion of the gut and generally inflated only at night. The mouth is small and does not reach the anterior edge of the eye. The eye is small and round in shape, with a mass of choroid tissue on the ventral margin. The long-based dorsal fins originate at about the level of the pectoral base. There is usually no gap between the vent and anal fins.

### **Similar group**

The larvae of labrids are most likely to be confused with Pseudochrominae and Pseudoplesiopinae larvae. It can be differentiated by the size of the mouth, head spination, pigments, eye shape, and fins count.

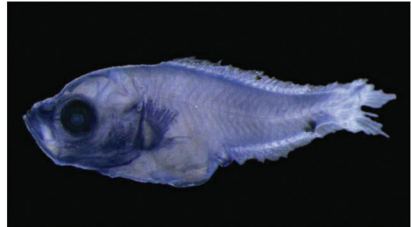


A



**Preflexion:** NL:3.47, HL:0.71, ED:0.25, BD:0.64.

B



**Flexion:** NL:3.73, HL:1.26, ED:0.39, BD:1.28,  
Artificial reef of a fishing vessel.

**Figure 18:** The larvae of labrids from Pulau Kapas waters. **A:** 3.47 mm **preflexion**, and **B:** 3.73 mm **flexion** stage.

## **Leiognathidae – Ponyfishes**

### **General Morphology**

The leiognathids larvae are moderate to deep and strongly compressed laterally. Some species become deeper following flexion. The head is moderate to large in size and initially deeply ovate with a steep, blunt, and concave snout.

### **Head Spination**

Head spination is strongly present. In particular, a preopercular and a prominent supraoccipital crest are present in preflexion larvae. Initially, the crest grows anteriorly, then extends well forward of the eye. Preopercular spines during the preflexion stage are long and become progressively shorter following the flexion stage. Depending on the species, the preopercular spine develops as either smooth, serrate or multipronged.

### **Pigmentation**

Generally, leiognathids larvae are lightly pigmented with vertically elongate embedded melanophores along the midline of the tail that consists of one to three melanophores per myomere. Melanophores are also present on the fin fold anterior to the anus, over the gut and gas bladder, and on the ventral midline of the gut and the cleithral symphysis.

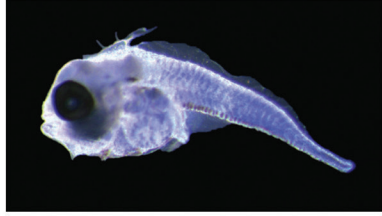
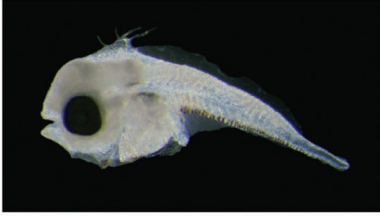
### **Diagnostic Character**

The larvae of leiognathids have 23 to 25 myomeres. The gut is coiled and compact. The small to the moderate gas bladder is dorsal to the apex of the gut. The mouth is small and reaches the anterior edge of the larvae's eye. The eye is round with moderate to large. Anlagen of the long-based dorsal and anal fins are present in preflexion larvae depending on the taxon.

### **Similar group**

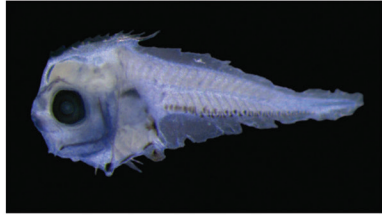
The leiognathids larvae may be confused with acanthurids, carangids, caproids, cepolids, lobotids, priacanthids, siganids, and lethrinids larvae.

A



Preflexion: NL:1.90, HL:0.47, ED:0.23, BD:0.64

B



Preflexion: NL:2.96, HL:0.80, ED:0.32, BD:1.24

**Figure 19:** The larvae of leiognathids from Pulau Kapas waters. **A:** 1.90 mm **preflexion**, and **B:** 2.96 mm **preflexion** stage.

## **Lethrinidae – Emperors, Large-eye Breams**

### **General Morphology**

The lethrinids larvae are moderate in-depth with a laterally compressed body. During early preflexion, the head is moderate and round with a short and rounded snout. However, the head becomes larger and more triangular with a more elongated snout by the middle of the preflexion stage. The mouth is moderately oblique and terminal and reaches the anterior edge of the eye.

### **Head Spination**

The head spination is well-developed and distinctive. The supraoccipital crest appears as an anlage on the nape then ossifies to become serrate. It then develops a posteriorly-directed, elongate, and serrate spine which laterally flattened in cross-section.

### **Pigmentation**

Generally, lethrinids larvae are lightly pigmented. Melanophores occur along the dorsal surface of the gut and on the ventral midline of the tail. Pigmentation on ventral midline pigment is gradually lost, and new pigmentation appears on the brain following the flexion stage. Serrate ridges form on the dentary and supraorbital in the preflexion stage. While during the flexion stage, it forms on the maxilla, infraorbital, pterotic, posttemporal, supracleithrum, opercle, subopercle, and interopercle.

### **Diagnostic Character**

The larvae of lethrinids have 23 to 25 myomeres. The gut is deeply coiled, compact, and triangular in shape. A small gas bladder that is situated above the anterior portion of the gut appears to be inflated at night. The eye is round and moderate to large in size.

### **Similar group**

Lethrinids are often confused with priacanthids, holocentrids, caproid, leiognathids, and cepolids larvae due to similar crest spines.

A



**Preflexion:** NL:2.84, HL:0.97, ED:0.37, BD:0.91

**Figure 20:** The larvae of lethinids collected from Pulau Kapas waters. **A:** 2.84 mm **preflexion.**

# **Lutjanidae – Snappers**

## **General Morphology**

The lutjanid larvae are elongate and become moderate to deep-bodied and laterally compressed. The head is moderate to large and moderately compressed.

## **Head Spination**

The head spination is especially well developed in caesionines and some lutjanines; in some, the spines at the preopercular angle may develop fine serrations. Much of the head spination may have disappeared by the time of settlement.

## **Pigmentation**

Lutjanid larvae are initially lightly pigmented. Melanophores are present on the dorsal of the gut and gas bladder, along with the membranes of the dorsal and pelvic fin spines and along the ventral edge of the tail.

## **Diagnostic Character**

The larvae of lutjanids have 24 myomeres. The gut is fully coiled with a triangular shape. A small gas bladder is located above the anterior portion of the gut. In preflexion, the larvae have a short, round snout, but during flexion, the snout becomes more elongate. The mouth is moderate to large, and the round eye is initially large but moderate in postflexion larvae. There is the presence of the spine at the angle and becomes the largest on the head during the flexion and postflexion stages. The larvae also have early-forming spines of the pelvic and dorsal fin.

## **Similar group**

The lutjanid larvae are likely to be confused with siganids, serranids, some melamphaid, gempylids and trichiurids larvae.

A



**Preflexion:** NL:3.79 HL:1.29, ED:0.44, BD:1.27,  
Artificial reef of a fishing vessel, sampling at 10m water depth.

B



**Flexion:** NL:4.67, HL:1.57, ED:0.52, BD:1.50,  
Artificial reef of oil rigs, sampling at 10m water depth.

**Figure 21:** The larvae of lutjanids collected from Pulau Kapas. **A:** 3.79 mm **preflexion**, and **B:** 4.67 mm **flexion** stage.

# **Monacanthidae – Leatherjackets**

## **General Morphology**

The monacanthid larvae range from deep-bodied to elongate and from strong to moderately compressed. There is a tendency for larvae to become more compressed with growth. The head size is species-dependent.

## **Head Spination**

The spine forms on the nape, and it migrates to a position anterior to the center of the eye and may even be located on the snout. This spine may be smooth or strongly armed with hooks and barbs. There is also the presence of a small, early-forming tuft of spinules on the preopercle that disappears prior to flexion.

## **Pigmentation**

The monacanthid larvae are moderate to heavily pigmented, and the pigment becomes heavier with increasing body size. Pigment on the gut is heavy, and large areas of the head are covered with small melanophores. Blotches of pigment are also present on the tail.

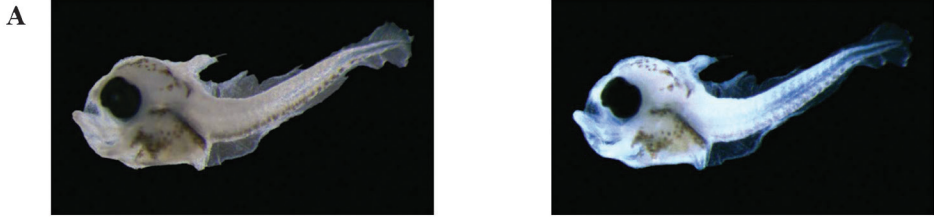
## **Diagnostic Character**

There are 17-31 myomeres. The gut is strongly coiled, even in the smallest post-yolk-sac larvae. A small, inconspicuous gas bladder is positioned above the anterior portion of the gut. The head is round in the early larvae stage but may become deep and triangular as flexion approaches. The snout is short initially but becomes longer in many species. The mouth is always small and may not reach the eye, especially in the larger larvae. The eye is round and often large. The dorsal fin spine is the first fin element to form before soft rays and flexion.

## **Similar group**

The monacanthids are likely to be confused with priacanthids, pomacentrids, dactylopterids, triacanthids, and balistids.

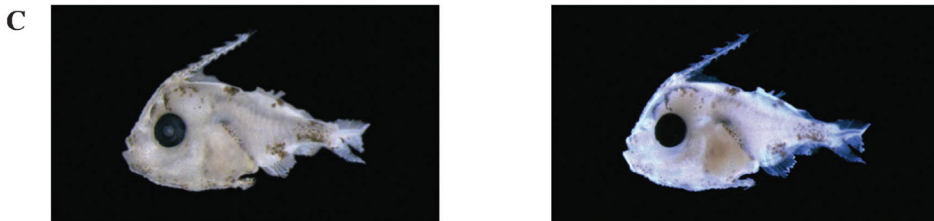




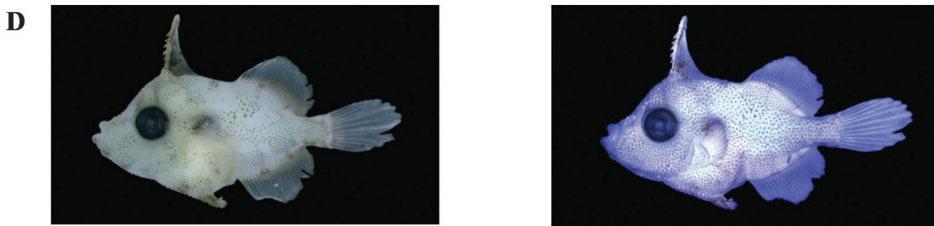
**Preflexion:** NL:2.38, HL: ED:0.30, BD:0.80



**Preflexion:** NL:3.05, HL: ED:0.50, BD:1.55



**Flexion:** NL:4.26, HL: ED:0.59, BD:1.90



**Postflexion:** TL:8.40, HL:2.55, ED:0.90, BD:3.18

**Figure 22:** The larvae of monacanthids from Pulau Kapas waters. **A:** 2.38 mm **preflexion**, and **B:** 3.05 mm **preflexion**, **C:** 4.26 mm **flexion** and **D:** 8.40 mm **postflexion** stage.

## **Mullidae – Goatfishes**

### **General Morphology**

The mullid larvae are elongate to moderate in-depth and laterally compressed. The moderate-size head is rounded dorsally, and the snout is short and steeply sloped.

### **Head Spination**

Almost no head spination.

### **Pigmentation**

The preflexion larvae have pigment on the dorsal surface of the gut and small melanophores along the ventral midline of the tail that is generally lost before flexion. The head pigmentation is more extensive during the development. A stripe with internal melanophores along the mid-lateral of the tail in flexion. In distinctive postflexion, melanophores appear along the dorsal margin of the tail.

### **Diagnostic Character**

The larvae have 23 to 25 myomeres. The gut is short and rounded. The gas bladder is covered by heavy pigment. The large eyes are round to slightly ovoid. The mouth is small to moderate in size, extends to about the anterior edge of the pupil, and is terminal and slightly oblique.

### **Similar group**

Early mullid larvae are similar to pomacentrids, nemipterids, gerreids, teraponids, sparids, and haemulids. The distinctive pigment pattern on the lateral surface and ventral margin of the tail is distinguished from nemipterids, gerreids, sparids, and haemulids. Some teraponids have this form of pigmentation but can be distinguished from mullids by the distance between the anus and the origin of the anal base. From postflexion, the absence of head spines in mullids are an important character.

A



**Preflexion:** NL:2.70, HL:0.70, ED:0.37, BD:0.68

B



**Flexion:** NL:3.57, HL:1.03, ED:0.43, BD:0.77

C



**Flexion:** NL:5.41, HL:1.67, ED:0.66, BD:1.12

D



**Postflexion:** BL:7.10, HL:2.29, ED:0.82, BD:1.67

**Figure 23:** The larvae of mullids from artificial reef of oil rigs in Pulau Kapas waters. **A:** 2.70 mm **preflexion**, **B:** 3.57 mm **flexion**, **C:** 5.41 mm **flexion** and **D:** 7.10 mm **postflexion** stage.

## **Nemipteridae - Thread-fin Breams, Monocle Breams**

### **General Morphology**

The nemipterid larvae are of moderate depth and laterally compressed. The head is moderate to large with a steeply sloped, short, rounded snout.

### **Head Spination**

The head spination is very limited. Most species have none, and when spination is present, it forms late and weak.

### **Pigmentation**

Prior to anal fin formation, nemipterid larvae have many tiny, evenly spaced melanophores extending along the entire ventral midline of the tail. Pigment generally occurs on the dorsal surface of the gas bladder, just anterior to the anus, and ventrally on the gut.

### **Diagnostic Character**

The characteristic of nemipterid is the tightly coiled gut, small gas bladder, 23-24 myomeres, large eye, and ventral midline pigment.

### **Similar group**

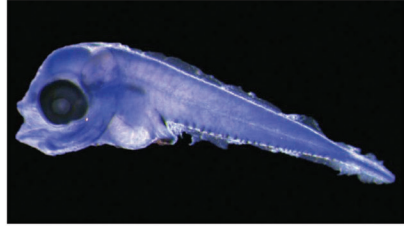
The nemipterid larvae are likely to be confused with scombrid (*Rastrelliger* sp.), ambassid, pinguipedid, sparid, pomacentrid, or mullid larvae.

A



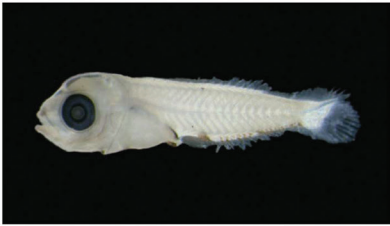
**Preflexion:** NL:2.48, HL:0.57, ED:0.30, BD:0.63

B



**Preflexion:** NL:2.69, HL:0.70, ED:0.34, BD:0.69

C



**Flexion:** NL:5.32, HL:1.60, ED:0.63, BD:1.26,  
Artificial reef of a fishing vessel.

**Figure 24:** The larvae of nemipterids from Pulau Kapas waters. **A:** 2.48 mm **preflexion**, **B:** 2.69 mm **preflexion** and **C:** 5.32 mm **flexion** stage.

## **Pegasidae - Sea moths**

### **General Morphology**

The pegasid larvae have a broad, round to slightly dorsoventrally flattened head and trunk with a laterally compressed, tapering tail. The head becomes increasingly flattened dorsoventrally following the growth of the larvae. The mouth is small in size and extremely protractile.

### **Head Spination**

The head spination is present. Larvae are enclosed in the dermal sac. When it recedes, supraoccipital, supraocular and posttemporal ridges form on the head.

### **Pigmentation**

Generally, pegasid larva is moderate to heavily pigmented. It has blotches to a more uniform distribution of melanophores over most of the body and pectoral fins. However, only light pigmentation is observed on caudal, dorsal, and anal fins, and no pigmentation occurs at the dermal sac and pelvic fins.

### **Diagnostic Character**

The larvae of pegasid have approximately 19-20 myomeres. In preflexion larvae, the gut is deep and extends to the mid-body, while in postflexion larvae, the gut extends as much as two-thirds body length. The gas bladder is not apparent. Depending on the species, the shape and length of the snout vary from short and tapered to elongate and flat. The larvae are enclosed in a dermal sac. Bony rings of the head and trunk begin to ossify at approximately 2 mm, but the tail is only fully encased in body rings at 7 mm.

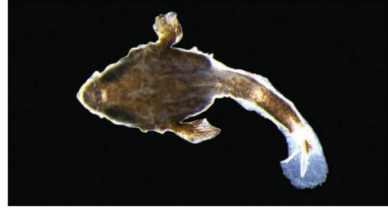
### **Similar group**

The pegasid larvae are often confused with the larvae of tetraodontiform and lophiiform.

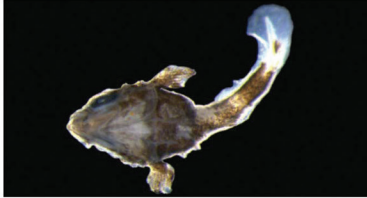
A



**Preflexion:** NL:3.27, HL:1.09,  
ED:0.43, BD:0.65



**Preflexion Dorsal View**



**Preflexion Ventral View**

B



**Postflexion:** TL:6.90, ED:0.26,  
BD:1.71



**Postflexion Dorsal View**



**Postflexion Ventral View**

**Figure 25:** The larvae of pegasids from Pulau Kapas waters. **A:** 3.27 mm **preflexion** and **B:** 6.90 mm **postflexion** stage.

# **Platycephalidae – Flatheads**

## **General Morphology**

The platycephalid larvae are elongate to moderate. Most taxa acquire a slightly hunch-backed appearance as the gut folds. The gut is long and straight in newly-hatched larvae. Folding of the gut begins shortly after hatching. While in most taxa, the gut is fully coiled by the late preflexion stage, in some species, the gut remains twisted until the flexion stage.

## **Head Spination**

Small preopercular spines are present. These become more prominent with growth and by flexion are small to large; the length and number of spines vary with species. Supraocular, parietal, supracleithral, and post-temporal spines are present in most taxa by the commencement of notochord flexion and form in other taxa during notochord flexion. The parietal spine is the most prominent of these and becomes bifurcate or finely serrate in some species in the postflexion stage. A spine develops on the pterotic and cleithrum during notochord flexion larvae. The infraorbital series and two opercular spines develop in postflexion larvae.

## **Pigmentation**

The platycephalid larvae have small melanophores scattered over the ventral midline of the tail, the lower jaw and gular membrane, operculum, and on the lateral edges of the upper jaw. Another pigment is variable depending on species, but pigment on the ventrum of the gut, on the dorsolateral surface of the trunk and tail, on the pectoral fin, and on the brain is common. Postflexion larvae often develop pigment on the spinous dorsal-fin membrane. Melanophores tend to be small and peppery.

## **Diagnostic Character**

There are 25-28 myomeres, and the body is round to ovoid in cross-section. An inconspicuous gas bladder is present above the anterior portion of the gut. The head is initially round and moderate to large. The eye is round and small, except in early preflexion larvae when it may be moderate. The large mouth extends to or past the mid-eye. In addition, the lower jaw protrudes beyond the upper jaw. The rays of the large, broad-based, fan-or wing-shaped pectoral fins begin to form by the commencement of notochord flexion and are fully formed early in the postflexion stage. Anlagen of the dorsal and anal fins appear in late preflexion larvae. Pelvic-fin buds develop in late preflexion or early flexion larvae, and all fin elements are present early in the postflexion stage.



## Similar group

The platycephalid larvae are most likely similar to scorpaeniform fishes, anthiine serranids, which are hoplichthyids and triglids. Some taxa of separate groups might be confused with early platycephalid larvae, including opistognathids, percophids, and sphyraenids.

A



**Preflexion:** NL:2.94, HL:1.09, ED:0.32, BD:0.82,  
Artificial reef of a fishing vessel, sampling at 10m water depth.

B



**Preflexion:** NL:3.00, HL:1.01, ED:0.31, BD:0.84,  
Artificial reef of a fishing vessel, sampling at 10m water depth.

C



**Postflexion:** SL:8.59, HL:3.54, ED:0.86, BD:2.23,  
Artificial reef of a fishing vessel, sampling at 10m water depth.

**Figure 26:** The larvae of platycephalids from Pulau Kapas waters. **A:** 2.94 mm **preflexion**, **B:** 3.00 mm **preflexion** and **C:** 8.59 mm **postflexion** stage.

## **Pomacentridae – Damselfishes**

### **General Morphology**

Early preflexion larvae are elongate and ovoid in cross-section. By flexion, larvae are slender to deep-bodied and laterally compressed and often have a hunchback appearance.

### **Head Spination**

Head spination is usually weak and consists of several small spines or serrations on the preopercle and interopercle, one small opercular spine, and supracleithral spine.

### **Pigmentation**

Preflexion pomacentrids have a fairly characteristic pigment pattern, with melanophores generally occurring on the brain, over the gut, and on the ventral and lateral midlines of the tail. Pigment also can be found on all other areas of the body, with the exception of the caudal fin rays.

### **Diagnostic Characters**

The pomacentrids larvae have 26-27 myomeres. There is the coiled triangular gut and a small inconspicuous gas bladder above the anterior portion of the gut. In preflexion larvae, the head is small to large and round with a short snout, while flexion and postflexion larvae have a moderately deep and laterally compressed head with a slightly elongate snout. The round eye is large in preflexion larvae and moderate to large after flexion. The pelvic bud and dorsal- and anal-fin anlagen form concurrently between mid-preflexion and early postflexion stages.

### **Similar groups**

There are lots of families most likely to be similar with a large number of perciform larvae. Perhaps the most similar are mullids and gerreids, especially in the preflexion stage.

A



**Flexion:** SL:6.08, HL:2.19, ED:0.77, BD:1.64

**Figure 27:** The larvae of pomacentrid collected from Pulau Kapas waters. **A:** 6.08 mm flexion stage.

## **Scaridae-Parrotfishes**

### **General Morphology**

In general, during preflexion, the larvae are elongated, and the body is ovoid in cross-section, with a deep caudal peduncle. The body is increasingly laterally compress with growth. The eye is small to moderate. It is usually ovoid to rectangular and becomes rounded in late postflexion larvae. The rugose gut extends to slightly beyond midbody and is initially straight with slight constriction at the posterior end. Shortly after flexion, the anterior portion of the gut become coiled, but this usually obscured within the body.

### **Head Spination**

No head spination.

### **Pigmentation**

The scarid larvae are lightly pigmented. They have pigment over the gut anterior to the anus and along the ventral midline of the tail.

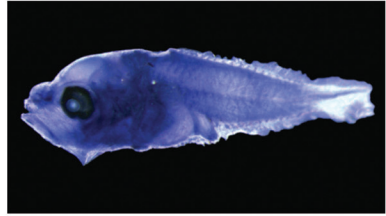
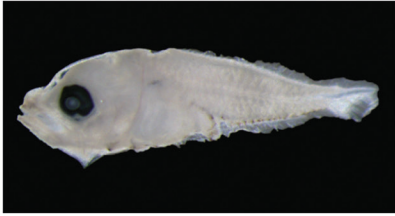
### **Diagnostic Character**

There are 25 myomeres. The rugose gut extends slightly beyond the mid-body and is initially straight with a slight constriction at the posterior end. After flexion, the anterior portion of the gut becomes coiled. A large gas bladder is located above the middle of the gut. The head is small initially but increases to moderate after flexion. The snout is slightly pointed to rounded. The small, nearly horizontal mouth reaches the anterior part of the eye, and the eye is small to moderate.

### **Similar Groups**

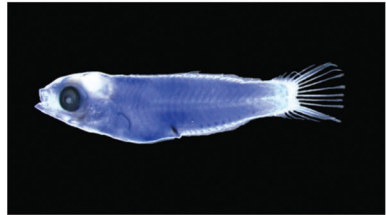
The preflexion larvae of scarid are most likely to be confused with myctophids, gobiids, ptereleotrine microdesmids, and eleotridids, while postflexion larvae are similar with deep-peduncled forms such as labrids and pseudochromids.

A



**Preflexion:** NL:2.50, HL:0.89, ED:0.28, BD:0.72

B



**Postflexion:** SL:7.24, HL:2.15, ED:0.72, BD:1.81

**Figure 28:** The larvae of scarid collected from Pulau Kapas waters. **A:** 2.50 mm **preflexion** and **B:** 7.24 mm **postflexion** stage.

## **Scatophagidae – Scats**

### **General Morphology**

Generally, scatophagids larvae have moderate depth and ovate in cross-section but quickly become deeper and more compressed, and deep-bodied.

### **Head Spination**

There is head spination, which is unique and remarkably developed. It is an elaborate series of blunt, broad spines and elevated ridges from the frontal. Spines develop swollen, granulate pad.

### **Pigmentation**

Depending on the stage of growth, pigmentation in scatophagids larvae varies from moderate to heavy. Generally, all have pigmentation on the forehead, dorsal surface of the gut and gas bladder, and the ventral midline of the tail, including on the opercle and the tip of the lower jaw. The pelvic fin is heavily pigmented. Pigmentation gradually spreads up and covers most of the body after flexion until the juvenile pattern is attained.

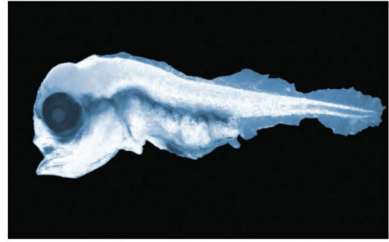
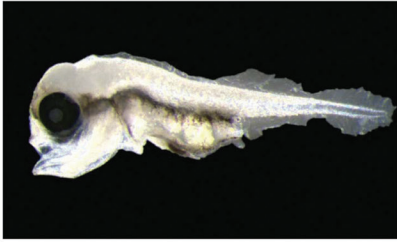
### **Diagnostic Character**

The larvae of scatophagids have 23 myomeres. The gut is longer than deep. The gas bladder is conspicuous and located over the anterior-most portion of the gut. However, in the postflexion stage, it may be enlarged and lie over the entire gut. The head is large and usually very deep and rounded but slowly becomes less steep as the larvae become increasingly deep-bodied. The mouth is moderate and initially reaches the anterior of the eye but becomes smaller following the flexion. The eye is large to moderate and round across the growth.

### **Similar group**

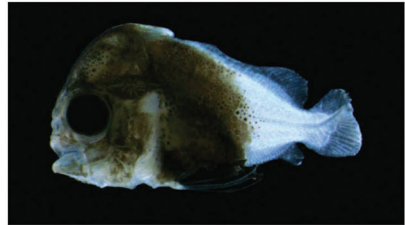
Scatophagids larvae are often confused with chaetodontid larvae due to well-developed head spination. Most chaetodontid has an armoured head but no swollen, granulate distal pads and heavily pigmented pelvic fin.

A



**Preflexion:** NL:1.95, HL:0.47, ED:0.23, BD:0.47,  
Kuala Pahang waters.

B



**Flexion:** NL:4.06, HL:1.56, ED:0.58, BD:2.17,  
Artificial reef of oil rigs, Pulau Kapas waters, sampling at 10m water depth.

**Figure 29:** A: 1.95 mm **preflexion** stage of scatophagid larva collected from Kuala Pahang waters and B: 4.06 mm **flexion** stage larva collected from Pulau Kapas waters.

## **Scombridae - Mackerels, Spanish Mackerels, Bonitos, Tunas.**

### **General Morphology**

The scombrids larvae are generally elongate to moderate in-depth and laterally compressed. They are abruptly deeper in the head and gut than in the tail. The proportion of PAL to BL usually increases as the larvae grow due to posterior migration of the anus. Similarly, the number of preanal myomeres increases at the expense of postanal myomeres. The head is moderate to large and varies in shape ranging from rounded to triangular and to elongate.

### **Head Spination**

Head spination varies among species. Generally, head spination is present in other scombrids larvae with moderate to long preopercular spines shortly after yolk-sac absorption. However, head spination is completely absent in *Rastrelliger* spp.

### **Pigmentation**

In general, in the preflexion stage, pigmentation appears dorsally on the gut and all for all scombrids larvae but *Rastrelliger* spp. develop pigmentation over the midbrain. Most taxa have a series of melanophores mid ventrally on the tail and tend to decrease following the growth.

### **Diagnostic Character**

The larvae of scombrids have 31 to 56 myomeres. The gut is coiled, compact, and triangular in shape. The gas bladder is inconspicuous and located above the apex of the gut. Depending on the taxa, the variation in the snout ranges from rounded and blunt to pointed, to triangulate, to elongate, and to greatly elongate. Generally, the snout lengthens relative to body length with growth. The mouth of scombrids larvae is large to huge except in Scombrini, where the mouth is moderate. The eye is rounded and moderate to large in size.

### **Similar group**

The larvae most likely to be confused with scombrids are nemipterids, sparids, microcanthids, pomacentrids, pinguipedids, blenniids, and some myctophids.



A



**Preflexion:** NL:3.69, HL:1.22, ED:0.46, BD:1.10

**Figure 30:** The larva of scombrid collected from Pulau Kapas waters. A: 3.69 mm preflexion stage.

## **Sillaginidae - Sand Smelts, Whitings.**

### **General Morphology**

Generally, sillaginids are elongate and have a compressed body. The head size is small to moderate during postflexion and slightly elongated.

### **Head Spination**

The head spination is poorly developed to the extent of underdeveloped.

### **Pigmentation**

The sillaginids are slightly pigmented and characterized by a single row of melanophores along the ventral midline of the trunks, tail, and often on the head.

### **Diagnostic Character**

They have 32 to 39 myomeres. The gut is initially straight with a relatively large diameter then coils during flexion. The gas bladder is not visible during daylight, but it is inflated and conspicuous at night. The mouth is moderately long and somehow has a pointed snout with a concave shape at the initial stage. The mouth also initially reaches the anterior margin of the eye. However, during the postflexion stage, the mouth gradually changes to a more or less straight profile and becomes smaller as the mouth does not reach the anterior margin of the eye. Generally, the eye is slightly elongated to round but is large to moderate in the preflexion stage and small to moderate in the postflexion stage.

### **Similar group**

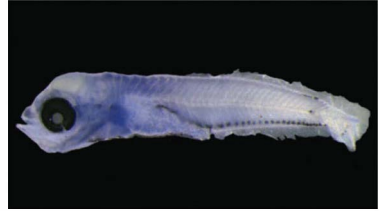
The larvae of sillaginids are often confused with tripterygiids, cheilodactylids, clinids, some creediids, terapontids, gobiids, pseudochromids, and bythitids.

A



**Preflexion:** NL:2.42, HL:0.50, ED:0.24,  
BD:0.48, Kuala Pahang waters.

B



**Flexion:** NL:4.05, HL:1.05, ED:0.39, BD:0.80,  
Artificial reef of oil rigs, Pulau Kapas waters, sampling at 10m water depth.

C



**Flexion:** NL:4.16, HL:1.20, ED:0.38, BD:0.78,  
Artificial reef of oil rigs at Pulau Kapas waters, sampling at 10m water depth.

**Figure 31:** A: 2.42 mm **preflexion** stage of sillaginid larva collected from Kuala Pahang waters. B: 4.05 mm **flexion** and C: 4.16 mm **flexion** stage larvae collected from Pulau Kapas waters.

## **Tetraodontidae – Puffers**

### **General Morphology**

Early preflexion larvae have an ovoid head and trunk and have a slender, tapered tail. By the late preflexion stage, the head and trunk are more robust, and the larvae are capable of inflation. The gut, which is broad and coiled, extends to about mid-body in early preflexion larvae and to beyond three-quarters of the body length in larger larvae. The head is large and ovoid rotund. The snout may be short and round or slightly elongated. The mouth is small and does not reach the anterior edge of the eye.

### **Head Spination**

No head spination.

### **Pigmentation**

The early preflexion of tetraodontids is heavily pigmented on the dorsal and dorsolateral surface of the gut and moderately pigmented on the top of the head. In larger larvae, pigment develops on the dorsal portion of the trunk.

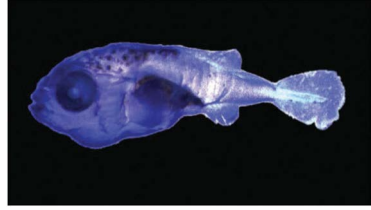
### **Diagnostic Character**

The larvae of tetraodontids have 19-21 myomeres. The broad, coiled gut extends to about mid-body in early preflexion larvae and to beyond three-quarters body length in larger larvae. A gas bladder is present but is often inconspicuous due to the dermal sac and heavy pigments. There are no pelvic fins.

### **Similar group**

Families that are most likely similar are ceratioid and antennariid anglerfish and other rotund tetraodontiform fishes with dermal sac (ostraciids, diodontids). Early tetraodontids larvae are slenderer than diodontids and ostraciid larvae and do not have a relatively uniform pigment pattern of the latter two.

A



**Preflexion:** NL:3.54, HL:1.12, ED:0.48, BD:1.13,  
Artificial reef of a fishing vessel.

B



**Preflexion:** NL:4.28, HL:1.34, ED:0.63,  
BD:2.20, Artificial reef of a fishing vessel.

C



**Preflexion:** NL:4.29, HL:1.53, ED:0.60, BD:1.52,  
Artificial reef of a fishing vessel.

**Figure 32:** The larvae of tetraodontids collected from Pulau Kapas waters. **A:** 3.54 mm preflexion, **B:** 4.28 mm preflexion and **C:** 4.29 mm preflexion stage.

# **Trichonotidae - Sand Divers**

## **General Morphology**

The trichonotids larvae are very elongate and ovoid in cross-section. In the preflexion stage, the head is round and small but gradually becomes elongated, moderate in size, and dorsoventrally flattened with growth.

## **Head Spination**

Head spination is absent.

## **Pigmentation**

Pigmentation of trichonotids larvae is sparsely pigmented. A few clusters of small melanophores occur dorsolaterally on the gut and laterally on the trunk of the larvae. Generally, tiny melanophores may extend to the length of the ventral midline of the tail or to be confined to its posterior-most portion.

## **Diagnostic Character**

The larvae of trichonotids have 50 to 56 myomeres. The gut is moderately long and straight along the body length. The gas bladder is small and located right above the middle of the gut and moves posteriorly with growth. Initially, the snout is short and round; however, it elongates as body size increases. The mouth is large, while the eyes are round to ovoid and moderate in size. The lower jaw projects beyond the upper jaw.

## **Similar group**

The larvae are very similar to the larvae of creediids, ammodytids, and kraemeriids. While trichonotids elongate bodies are often confused with the larvae of microdesmids, clupeiformes, and gonorynchiformes.

A



**Flexion:** NL:5.09, HL:1.25, ED:0.30, BD:0.51  
Artificial reef of oil rigs

B



**Flexion:** NL:6.17, HL:1.52, ED:0.30, BD:0.60  
Artificial reef of oil rigs.

C



**Flexion:** NL:8.42, HL:1.88, ED:0.35, BD:0.64,  
Artificial reef of a fishing vessel, sampling at 10m water depth.

D



**Postflexion:** SL:12.67, HL:2.75, ED:0.42, BD:0.95,  
Artificial reef of oil rigs.

**Figure 33:** The larvae of trichonotids collected from Pulau Kapas waters. **A:** 5.09 mm flexion, **B:** 6.17 mm flexion, **C:** 8.42 mm flexion and **D:** 12.67 mm postflexion stage.

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## APPENDIX

Images of adult fishes according to families.



Apogonidae



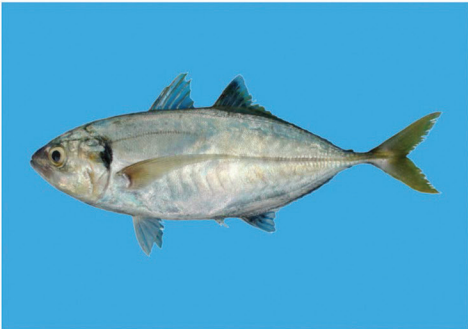
Bothidae



Bregmacerotidae



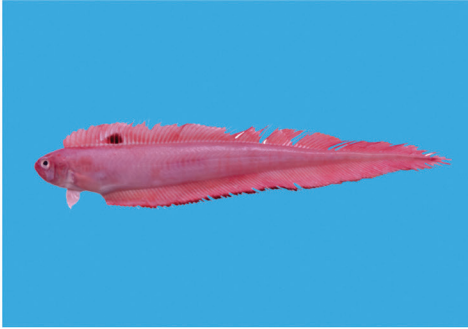
Callionymidae ( dorsal view )



Carangidae



Centriscidae



Cepolidae



Cynoglossidae



Drepaneidae



Engraulidae



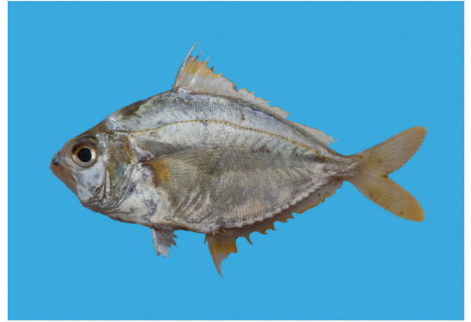
Gerreidae



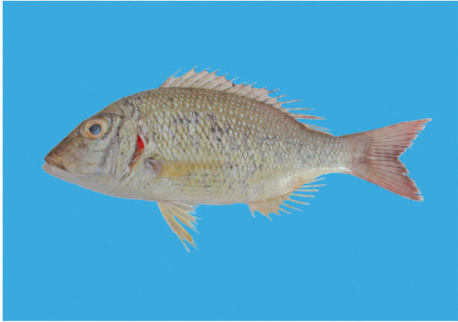
Gobiidae



Labridae



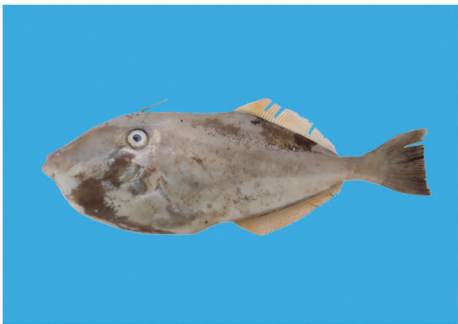
Leiognathidae



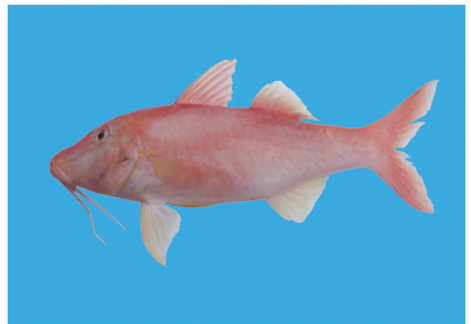
Lethrinidae



Lutjanidae



Monacanthidae



Mullidae



Nemipteridae



Pegasidae (dorsal view)



Platycephalidae



Pomacentridae



Scaridae



Scatophagidae



Scombridae



Sillaginidae



Tetraodontidae





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